PAI Assignment

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Assignment No-01

A. Hello world

B. GDB execution

#Code-

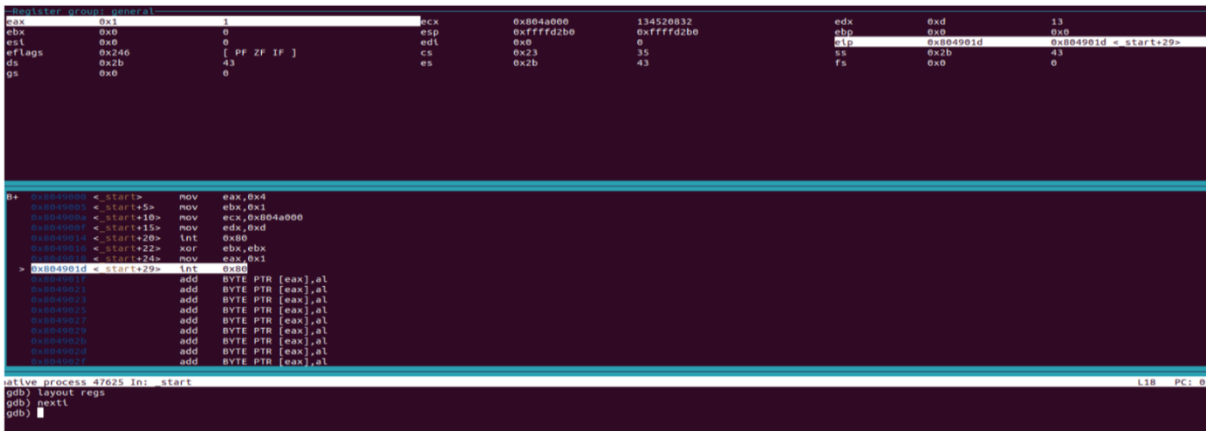
```
global _start

section .data
    hello db "Hello, World", 10
    length equ $ - hello

section .text

_start:
    mov eax, 4                          ; write to file
```

```
mov ebx, 1                      ; STDOUT handle
mov ecx, hello                  ; our message
mov edx, length                 ; size of our message
int 0x80                        ; execute the syscall

xor ebx, ebx                    ; send 0 as 'exit code'
mov eax,1                       ; terminate process
int 0x80                        ; execute the syscall
```

#Output-

Debugging-

(GDB) Hello World



Assignment No-02

A. Name And Surname Input

B. GDB execution

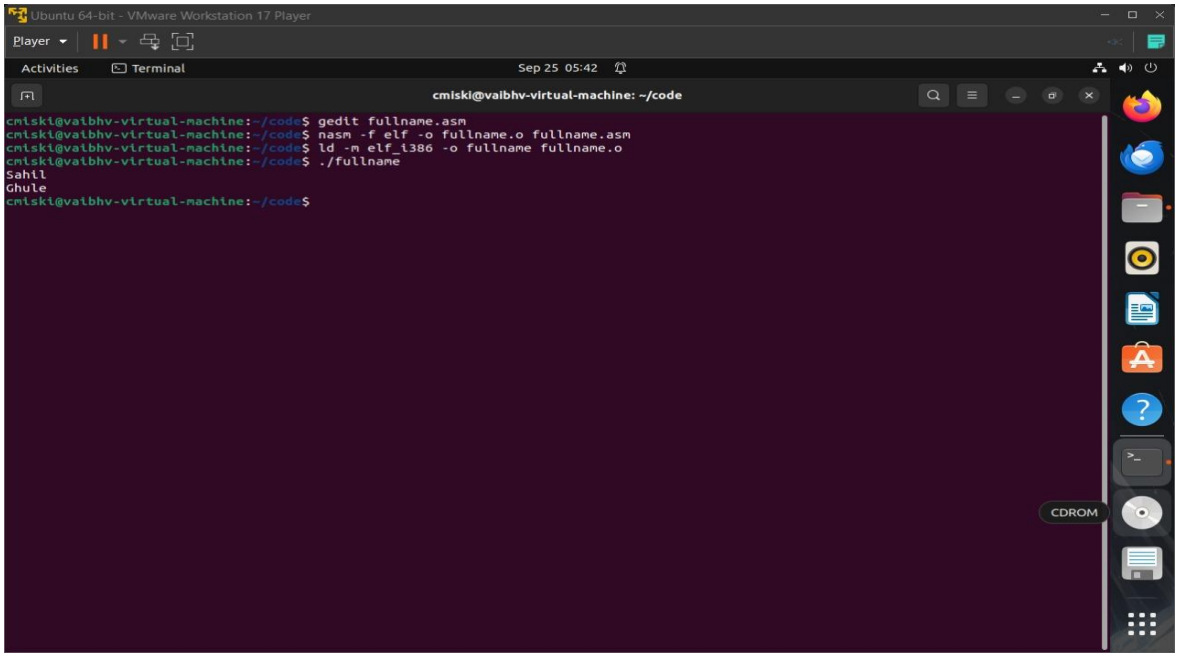
#Code-

section .data

```
    name db "Sahil ",10

    len_name equ $ - name

    surname db "Ghule",10

    len_surname equ $ - surname



section .text

    global _start



_start:

    mov eax, 4

    mov ebx, 1

    mov ecx, name

    mov edx, len_name
```

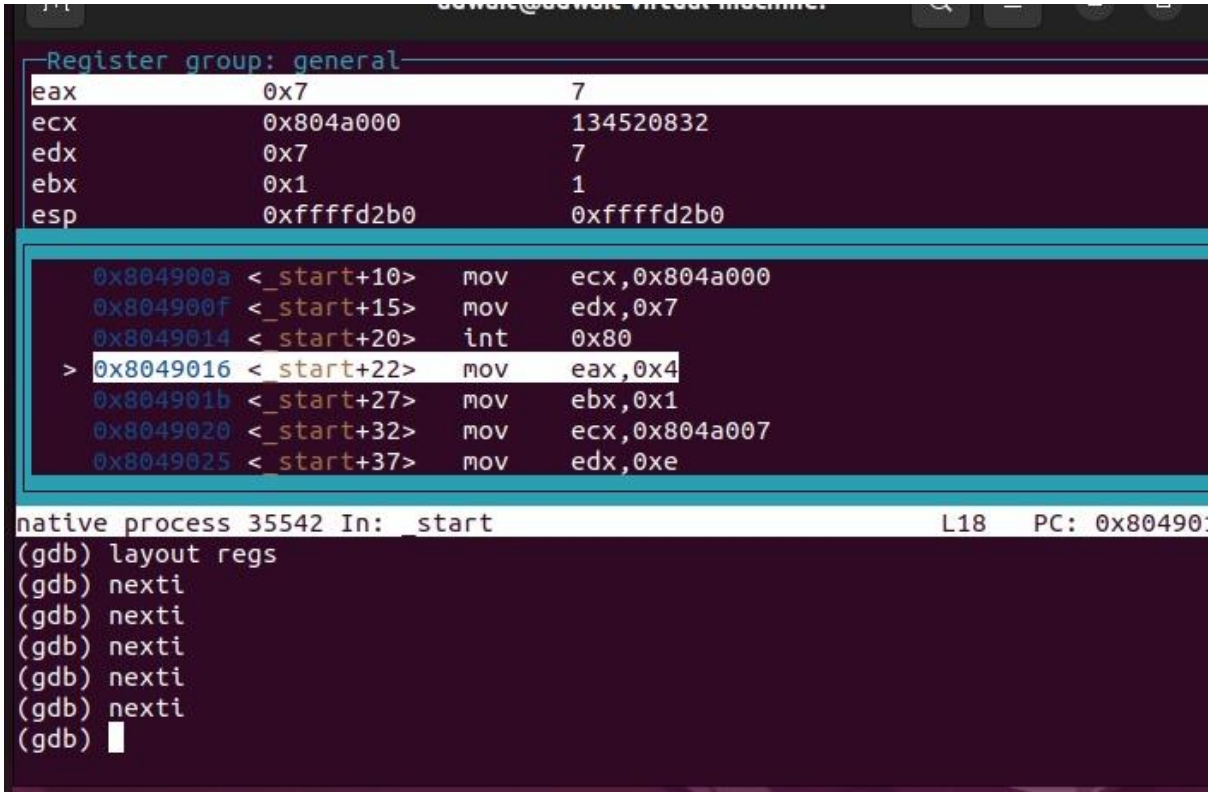
```
int 0x80

mov eax, 4

mov ebx, 1

mov ecx, surname

mov edx, len_surname

int 0x80

mov eax, 1

xor ebx, ebx

int 0x80
```

#Output



Debugging-

(GDB) Name And Surname



Assignment No-03

A. Addition, Subtraction, Multiplication, Division (Terminal Output)

B. Addition, Subtraction, Multiplication, Division

(GDB execution)

A) Terminal Output

i. Addition Code-

```
section .data
    msg1 db "Enter first number: ",0
    len1 equ $-msg1
    msg2 db "Enter second number: ",0
    len2 equ $-msg2
    resultMsg db "Result = ",0
    lenRes equ $-resultMsg
    newline db 10

section .bss
    num1 resb 10
    num2 resb 10
    res  resb 10

section .text
    global _start

_start:
    ; Ask for first number
    mov eax, 4
```

```
mov ebx, 1
mov ecx, msg1
mov edx, len1
int 0x80

; Read input (up to 10 chars)
mov eax, 3
mov ebx, 0
mov ecx, num1
mov edx, 10
int 0x80

; Convert num1 -> integer
mov esi, num1
call atoi
mov ebx, eax          ; store first number in ebx

; Ask for second number
mov eax, 4
mov ebx, 1
mov ecx, msg2
mov edx, len2
int 0x80

; Read input
mov eax, 3
```

```
mov ebx, 0
mov ecx, num2
mov edx, 10
int 0x80

; Convert num2 -> integer
mov esi, num2
call atoi

; Add
add eax, ebx          ; eax = num1 + num2

; Convert result back to string
mov edi, res+10       ; point to end of buffer
call itoa             ; eax -> string in res

; Print "Result = "
mov eax, 4
mov ebx, 1
mov ecx, resultMsg
mov edx, lenRes
int 0x80

; Print result
mov eax, 4
mov ebx, 1
```

```
    mov ecx, edi
    mov edx, 10
    int 0x80

    ; Print newline
    mov eax, 4
    mov ebx, 1
    mov ecx, newline
    mov edx, 1
    int 0x80

    ; Exit
    mov eax, 1
    xor ebx, ebx
    int 0x80

; -------- Functions --------
; atoi: ASCII string -> integer
; esi = string address, eax = result
atoi:
    xor eax, eax
.next:
    mov bl, [esi]
    cmp bl, 10        ; newline?
    je .done
    sub bl, '0'
```

```
    imul eax, eax, 10
    add eax, ebx
    inc esi
    jmp .next
.done:
    ret

; itoa: integer (eax) -> string, edi = buffer end
; returns edi pointing to start of string
itoa:
    mov ecx, 10
    mov edx, 0
.loop:
    xor edx, edx
    div ecx
    add dl, '0'
    dec edi
    mov [edi], dl
    test eax, eax
    jnz .loop
    ret
```

#Output-

```
kaizen@kaizen:~$ gedit add2.asm
kaizen@kaizen:~$ nasm -f elf32 add2.asm -o  add2.o
kaizen@kaizen:~$ ld -m elf_i386 add2.o -o add2
kaizen@kaizen:~$ ./add2
Enter first number: 10
Enter second number: 20
Result = 30
kaizen@kaizen:~$
```

---

ii. Subtraction Code-

```
section .data
    msg1 db "Enter first number: ",0
    l1 equ $-msg1
    msg2 db "Enter second number: ",0
    l2 equ $-msg2
    msg3 db "Subtraction = ",0
    l3 equ $-msg3
    minus db "-",0
    nl db 10

section .bss
    num1 resb 16
    num2 resb 16
    outbuf resb 16
```

```
section .text
    global _start

atoi:   ; ecx=buf → eax=int
    xor eax,eax
.next:  mov bl,[ecx]
    cmp bl,'0'     ; below '0'
    jb .done
    cmp bl,'9'     ; above '9'
    ja .done
    sub bl,'0'
    imul eax,eax,10
    add eax,ebx
    inc ecx
    jmp .next
.done:  ret

itoa:   ; eax=num, edi=buf
    mov ecx,0
.loop:  xor edx,edx
    mov ebx,10
    div ebx
    add dl,'0'
    push edx
    inc ecx
    test eax,eax
```

```
    jnz .loop
.w:     pop edx
    mov [edi],dl
    inc edi
    loop .w
    mov edx,edi
    sub edx,outbuf
    ret

_start:
    ; ---- prompt 1 ----
    mov eax,4; write
    mov ebx,1
    mov ecx,msg1
    mov edx,l1
    int 0x80
    ; read first
    mov eax,3
    mov ebx,0
    mov ecx,num1
    mov edx,16
    int 0x80
    mov ecx,num1
    call atoi
    push eax        ; save first
```

```
; ---- prompt 2 ----
mov eax,4
mov ebx,1
mov ecx,msg2
mov edx,l2
int 0x80
; read second
mov eax,3
mov ebx,0
mov ecx,num2
mov edx,16
int 0x80
mov ecx,num2
call atoi
mov ebx,eax     ; second
pop eax         ; first

sub eax,ebx
mov ecx,eax

; ---- print result label ----
mov eax,4
mov ebx,1
mov ecx,msg3
mov edx,l3
int 0x80
```

```
    ; ---- handle sign ----
    cmp ecx,0
    jge .pos
    neg ecx
    mov eax,4
    mov ebx,1
    mov ecx,minus
    mov edx,1
    int 0x80
.pos:
    ; convert & print number
    mov eax,ecx
    mov edi,outbuf
    call itoa
    mov eax,4
    mov ebx,1
    mov ecx,outbuf
    int 0x80

    ; newline
    mov eax,4
    mov ebx,1
    mov ecx,nl
    mov edx,1
    int 0x80
```

```
; exit
mov eax,1
xor ebx,ebx
int 0x80
```

#Output-

```
kaizen@kaizen:~$ nasm -f elf32 sub2.asm -o  sub2.o
kaizen@kaizen:~$ ld -m elf_i386 sub2.o -o sub2
kaizen@kaizen:~$ ./sub2
Enter first number: 50
Enter second number: 25
Subtraction = 25
kaizen@kaizen:~$
```

---

iii. Multiplication Code-

```
section .data
    msg1 db "Enter first number: ",0
    len1 equ $-msg1
    msg2 db "Enter second number: ",0
    len2 equ $-msg2
    resmsg db "Multiplication = ",0
    lenres equ $-resmsg
```

```
    newline db 10

section .bss
    num1 resb 16
    num2 resb 16
    outbuf resb 16

section .text
    global _start

; --- atoi: ECX=buffer, returns EAX=int ---
atoi:
    xor eax, eax
.next:
    mov bl, [ecx]
    cmp bl, '0'
    jb .done
    cmp bl, '9'
    ja .done
    sub bl, '0'
    imul eax, eax, 10
    add eax, ebx
    inc ecx
    jmp .next
.done:
    ret
```

```
; --- itoa: EAX=number, EDI=buffer, returns length in EAX ---
itoa:
    mov ebx, 10
    xor ecx, ecx        ; digit count
.loop:
    xor edx, edx
    div ebx             ; EAX/10, remainder in EDX
    add dl, '0'
    push edx
    inc ecx
    test eax, eax
    jnz .loop
    mov eax, ecx        ; length
    mov esi, edi
.poploop:
    pop edx
    mov [esi], dl
    inc esi
    loop .poploop
    mov byte [esi], 0
    ret

; --- main ---
_start:
    ; prompt 1
```

```
mov eax,4;write
mov ebx,1
mov ecx,msg1
mov edx,len1
int 0x80

; read num1
mov eax,3
mov ebx,0
mov ecx,num1
mov edx,16
int 0x80

; prompt 2
mov eax,4
mov ebx,1
mov ecx,msg2
mov edx,len2
int 0x80

; read num2
mov eax,3
mov ebx,0
mov ecx,num2
mov edx,16
int 0x80
```

```
; convert numbers
mov ecx,num1
call atoi
push eax
mov ecx,num2
call atoi
mov ebx,eax
pop eax

imul eax, ebx       ; multiply

; print "Multiplication = "
push eax
mov eax,4
mov ebx,1
mov ecx,resmsg
mov edx,lenres
int 0x80
pop eax

; convert result to string
mov edi,outbuf
call itoa
mov edx,eax         ; length
```

```
; print result
mov eax,4
mov ebx,1
mov ecx,outbuf
int 0x80

; print newline
mov eax,4
mov ebx,1
mov ecx,newline
mov edx,1
int 0x80

; exit
mov eax,1
xor ebx,ebx
int 0x80
```

#Output-

```
kaizen@kaizen:~$ gedit multi2.asm
kaizen@kaizen:~$ nasm -f elf32 multi2.asm -o  multi2.o
kaizen@kaizen:~$ ld -m elf_i386 multi.o -o multi2
ld: cannot find multi.o: No such file or directory
kaizen@kaizen:~$ ld -m elf_i386 multi2.o -o multi2
kaizen@kaizen:~$ ./multi2
Enter first number: 2
Enter second number: 2
Multiplication = 4
```

iv. Division Code-

```
section .data
    msg1 db "Enter dividend: ",0
    len1 equ $-msg1
    msg2 db "Enter divisor: ",0
    len2 equ $-msg2
    resmsg db "Quotient = ",0
    lenres equ $-resmsg
    newline db 10

section .bss
    num1 resb 16
    num2 resb 16
    outbuf resb 16

section .text
    global _start

_start:
    ; prompt dividend
    mov eax,4
    mov ebx,1
    mov ecx,msg1
    mov edx,len1
    int 0x80
```

```
    ; read dividend
    mov eax,3
    mov ebx,0
    mov ecx,num1
    mov edx,16
    int 0x80

    ; atoi inline for dividend
    xor eax,eax
    mov esi,num1
.d1: mov bl,[esi]
    cmp bl,'0'
    jb .d1done
    cmp bl,'9'
    ja .d1done
    sub bl,'0'
    imul eax,eax,10
    add eax,ebx
    inc esi
    jmp .d1
.d1done:
    push eax    ; save dividend

    ; prompt divisor
    mov eax,4
```

```
    mov ebx,1
    mov ecx,msg2
    mov edx,len2
    int 0x80

    ; read divisor
    mov eax,3
    mov ebx,0
    mov ecx,num2
    mov edx,16
    int 0x80

    ; atoi inline for divisor
    xor ebx,ebx
    mov esi,num2
.d2: mov dl,[esi]
    cmp dl,'0'
    jb .d2done
    cmp dl,'9'
    ja .d2done
    sub dl,'0'
    imul ebx,ebx,10
    add ebx,edx
    inc esi
    jmp .d2
.d2done:
```

```
    ; divide
    pop eax     ; dividend
    xor edx,edx
    div ebx     ; quotient in eax
    ; print message
    push eax
    mov eax,4
    mov ebx,1
    mov ecx,resmsg
    mov edx,lenres
    int 0x80
    pop eax

    ; itoa inline
    mov edi,outbuf
    mov ecx,0
.conv: xor edx,edx
    mov ebx,10
    div ebx
    add dl,'0'
    push edx
    inc ecx
    test eax,eax
    jnz .conv
    mov eax,ecx
```

```
    mov esi,edi
.writedigs:
    pop edx
    mov [esi],dl
    inc esi
    loop .writedigs
    mov byte [esi],0
    mov edx,eax

    ; print result
    mov eax,4
    mov ebx,1
    mov ecx,outbuf
    int 0x80

    ; newline
    mov eax,4
    mov ebx,1
    mov ecx,newline
    mov edx,1
    int 0x80
    ; exit
    mov eax,1
    xor ebx,ebx
    int 0x80
```

#Output-

```
kaizen@kaizen:~$ gedit div2.asm
kaizen@kaizen:~$ nasm -f elf32 div2.asm -o  div2.o
kaizen@kaizen:~$ ld -m elf_i386 div2.o -o div2
kaizen@kaizen:~$ ./div2
Enter first number: 30
Enter second number: 2
Division = 15, Remainder = 0
kaizen@kaizen:~$
```

B) GDB Execution

i. Addition Code-

```
section .data
    result db 0       ; to store addition result

section .text
    global _start

_start:
    mov al, 50       ; load first number into AL
    add al, 30       ; add second number to AL
    mov [result], al ; store the result (80) in memory

    mov eax, 1       ; sys_exit system call
    xor ebx, ebx     ; return 0
```

int 0x80

#Output-

Addition Of Number 50+30= 80

```
Register group: general
eax            0x50                80                      ecx            0x0                0
edx            0x0                 0                       ebx            0x0                0
esp            0xffffd2d0          0xffffd2d0              ebp            0x0                0x0
esi            0x0                 0                       edi            0x0                0
eip            0x8049009           0x8049009 <_start+9>    eflags         0x216              [ PF AF IF ]
cs             0x23                35                      ss             0x2b               43
ds             0x2b                43                      es             0x2b               43
fs             0x0                 0                       gs             0x0                0

B+  0x8049000 <_start>      mov    al,0x32
    0x8049002 <_start+2>    add    al,0x1e
    0x8049004 <_start+4>    mov    ds:0x804a000,al
  > 0x8049009 <_start+9>    mov    eax,0x1
    0x804900e <_start+14>   xor    ebx,ebx
    0x8049010 <_start+16>   int    0x80
    0x8049012               add    BYTE PTR [eax],al
    0x8049014               add    BYTE PTR [eax],al
    0x8049016               add    BYTE PTR [eax],al
    0x8049018               add    BYTE PTR [eax],al
    0x804901a               add    BYTE PTR [eax],al
    0x804901c               add    BYTE PTR [eax],al
    0x804901e               add    BYTE PTR [eax],al
    0x8049020               add    BYTE PTR [eax],al
native process 4863 In:  _start                                   L??   PC: 0x8049009
(gdb) layout regs
(gdb) nexti
0x08049002 in _start ()
(gdb) nexti
0x08049004 in _start ()
(gdb) nexti
0x08049009 in _start ()
(gdb)
```

ii. Subtraction Code-

```
section .data
    result db 0             ; store result here

section .bss

section .text
    global _start
_start:

    ; Put values into registers
    mov eax, 50             ; EAX = 50
    mov ebx, 30             ; EBX = 30

    ; Subtraction
    sub eax, ebx            ; EAX = EAX - EBX (50 - 30 = 20)

    ; Store only the lowest byte of result (20 fits in 1 byte)
    mov [result], al

    ; Exit syscall
    mov eax, 1
    xor ebx, ebx
```

int 0x80

#Output-

Subtraction Of Number 50-30= 20

```
Register group: general
eax            0x14               20                 ecx            0x0            0
edx            0x0                0                  ebx            0x1e           30
esp            0xffffd2d0         0xffffd2d0         ebp            0x0            0x0
esi            0x0                0                  edi            0x0            0
eip            0x804900c          0x804900c <_start+12>  eflags     0x216          [ PF AF IF ]
cs             0x23               35                 ss             0x2b           43
ds             0x2b               43                 es             0x2b           43
fs             0x0                0                  gs             0x0            0

B+  0x8049000 <_start>      mov    eax,0x32
    0x8049005 <_start+5>    mov    ebx,0x1e
    0x804900a <_start+10>   sub    eax,ebx
  > 0x804900c <_start+12>   mov    ds:0x804a000,al
    0x8049011 <_start+17>   mov    eax,0x1
    0x8049016 <_start+22>   xor    ebx,ebx
    0x8049018 <_start+24>   int    0x80
    0x804901a               add    BYTE PTR [eax],al
    0x804901c               add    BYTE PTR [eax],al
    0x804901e               add    BYTE PTR [eax],al
    0x8049020               add    BYTE PTR [eax],al
    0x8049022               add    BYTE PTR [eax],al
    0x8049024               add    BYTE PTR [eax],al
native process 4338 In: _start                                   L??   PC: 0x804900c
(gdb) nexti
0x08049005 in _start ()
(gdb) nexti
0x0804900a in _start ()
(gdb) nexti
0x0804900c in _start ()
(gdb)
```

---

3) Multiplication Code-

section .data

```
    result dw 0      ; 16-bit result storage

section .text
    global _start

_start:
    mov al, 12       ; AL = 12
    mov bl, 15       ; BL = 15
    mul bl           ; AX = AL * BL → 180
    mov [result], ax ; store result (180)

    mov eax, 1       ; sys_exit
    xor ebx, ebx
    int 0x80
```

#Output-

Multiplication Of Number 12*15= 180

```
Register group: general
eax            0xb4               180                    ecx            0x0            0
edx            0x0                0                      ebx            0xf            15
esp            0xffffd2d0         0xffffd2d0             ebp            0x0            0x0
esi            0x0                0                      edi            0x0            0
eip            0x8049006          0x8049006 <_start+6>   eflags         0x202          [ IF ]
cs             0x23               35                     ss             0x2b           43
ds             0x2b               43                     es             0x2b           43
fs             0x0                0                      gs             0x0            0

B+  0x8049000 <_start>      mov    al,0xc
    0x8049002 <_start+2>    mov    bl,0xf
    0x8049004 <_start+4>    mul    bl
  > 0x8049006 <_start+6>    mov    ds:0x804a000,ax
    0x804900c <_start+12>   mov    eax,0x1
    0x8049011 <_start+17>   xor    ebx,ebx
    0x8049013 <_start+19>   int    0x80
    0x8049015               add    BYTE PTR [eax],al
    0x8049017               add    BYTE PTR [eax],al
    0x8049019               add    BYTE PTR [eax],al
    0x804901b               add    BYTE PTR [eax],al
    0x804901d               add    BYTE PTR [eax],al
    0x804901f               add    BYTE PTR [eax],al
    0x8049021               add    BYTE PTR [eax],al
native process 4564 In: _start                                   L??   PC: 0x8049006
(gdb) layout regs
(gdb) nexti
0x08049002 in _start ()
(gdb) nexti
0x08049004 in _start ()
(gdb) nexti
0x08049006 in _start ()
(gdb)
```

---

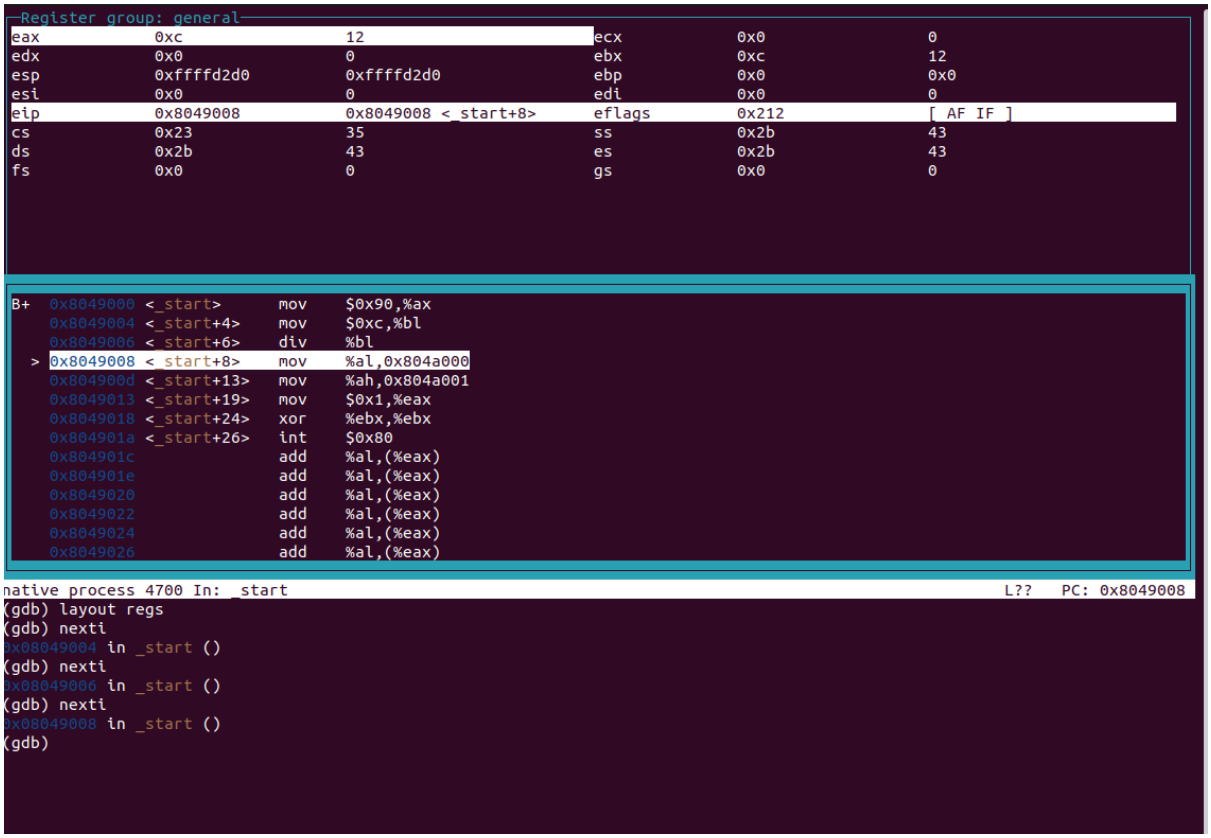
iii. Division Code

```
section .data
    quotient db 0       ; to store quotient
    remainder db 0      ; to store remainder

section .text
```

```
    global _start

_start:
    mov ax, 144      ; AX = 144
    mov bl, 12       ; BL = 12
    div bl           ; AL = 144 ÷ 12 = 12, AH = 0
    mov [quotient], al
    mov [remainder], ah

    mov eax, 1       ; sys_exit
    xor ebx, ebx
    int 0x80
```

#Output-

Division Of Number 12/144= 12



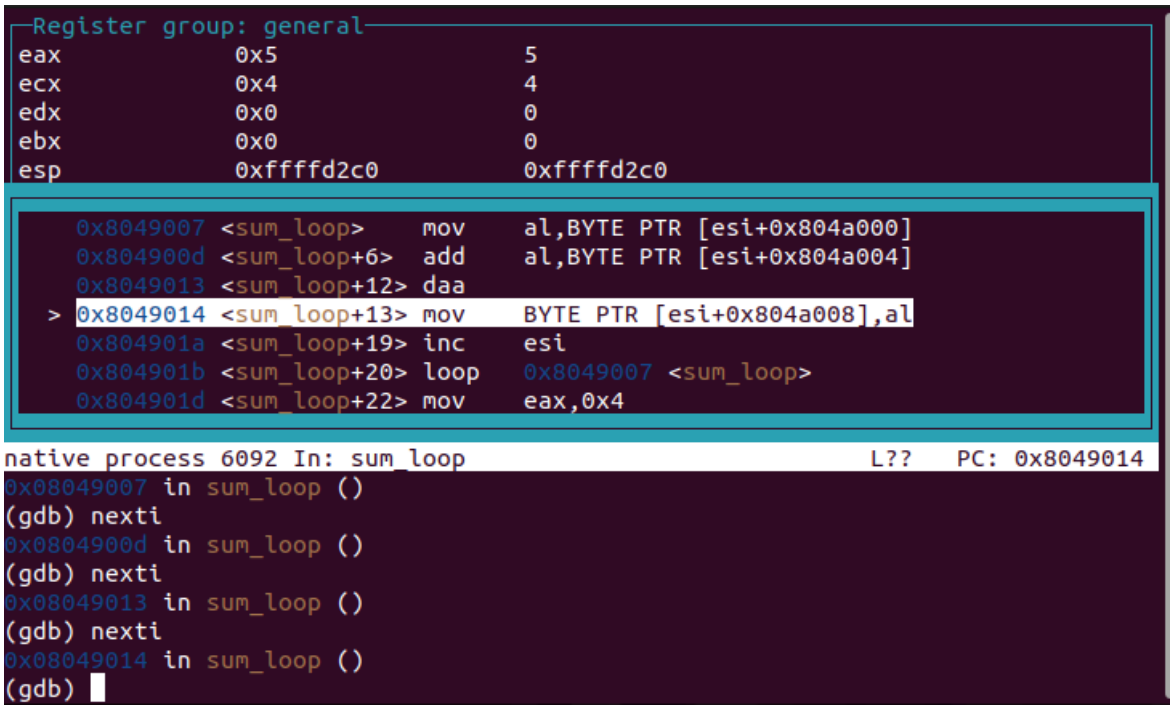
Assignment No-04

A. Array Addition (result less than 10 and 2nd by using AAM)

Array Addition Code-

```
section .text
global _start

_start:

    mov eax, x      ; pointer to numbers
    mov ebx, 0      ; EBX will store the sum
    mov ecx, 5      ; number of elements

top:
    add bl, [eax]   ; add current element to sum
    inc eax         ; move pointer to next element
    loop top        ; repeat until ECX = 0

done:
    add bl, '0'     ; convert to ASCII
    mov [sum], bl   ; store result in "sum"

display:
    mov edx, 1      ; message length
    mov ecx, sum    ; message to write
    mov ebx, 1      ; file descriptor (stdout)
    mov eax, 4      ; system call number (sys_write)
    int 0x80        ; call kernel

    mov eax, 1      ; system call number (sys_exit)
```

```
    int 0x80        ; call kernel


section .data
x:
    times 5 db 0    ; reserve 5 numbers (user can modify later)


sum:
    db 0, 0xa       ; result + newline
```



B. String Operation.

```
global _start
```

```
section .text
_start:
    cld                 ; clear direction flag (process forward)
    mov ecx, len        ; counter = string length
    mov esi, s1         ; source string
    mov edi, s2         ; destination string

loop_here:
    lodsb               ; load byte from [esi] into AL
    or al, 20h          ; convert uppercase to lowercase (ASCII trick)
    stosb               ; store AL into [edi]
    loop loop_here      ; repeat ECX times

    ; print result
    mov edx, len        ; message length (not hardcoded 20)
    mov ecx, s2         ; message to write
    mov ebx, 1          ; file descriptor (stdout)
    mov eax, 4          ; system call (sys_write)
    int 0x80

    ; exit
    mov eax, 1          ; sys_exit
    xor ebx, ebx        ; return 0
    int 0x80

section .data
```

```
s1 db 'HELLO, WORLD', 0xa  ; source string with newline
len equ $-s1               ; string length

section .bss
s2 resb len                ; reserve same size as s1
```

```
kaizen@kaizen:~$ gedit stringsize.asm
kaizen@kaizen:~$ nasm -f elf32 stringsize.asm -o  stringsize.o
kaizen@kaizen:~$ ld -m elf_i386 stringsize.o -o stringsize
kaizen@kaizen:~$ ./stringsize
hello, world kaizen@kaizen:~$
```

v